REMARKS

Claims 43-60 are in the application. Independent Claim 48 (the only independent claim in the present application) is amended to specify that the at least one connector species comprises an electrically addressable molecular species, as disclosed on page 3, lines 9-11 of the specification.

Claims 48-60 are rejected under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 34-40 and 45-49 of U.S. Patent 6,314,019.

In an effort to advance the prosecution, enclosed herewith is a Terminal Disclaimer, executed by Denise A. Lee, attorney of record, on behalf of the assignee, Hewlett-Packard, to overcome the double patenting rejection. No agreement with the Examiner's rejection should be inferred thereby.

Reconsideration of the rejection of Claims 48-60 under the judicially created doctrine of obviousness-type double patenting as being unpatentable over Claims 34-40 and 45-49 of U.S. Patent 6,314,019 is respectfully requested.

Claims 48, 50-56, and 60 are rejected under 35 USC 102(b) as being anticipated by Nagasubramanian et al (U.S. Patent 5,272,359).

Nagasubramanian et al disclose a reversible non-volatile switch based on a TCNQ charge transfer complex. In particular, a solid-state synaptic memory matrix having switchable weakly conductive connections at each node whose resistances can be selectively increased or decreased over several orders of magnitude by control signals of opposite polarity, and which will remain stable after the signals are removed, comprises an insulated substrate, a set of electrical conductors upon which is deposited a layer of an organic conducting polymer, which changes from an insulator to a conductor upon the transfer of electrons, such as polymerized pyrrole doped with 7,7,8,8-tetracyanoquinodimethane (TCNQ), covered by a second set of conductors at right angles to the first.

Applicants' Claim 48, as amended, recites a method of operating a crossed-wire device. The crossed-wire device comprises a pair of crossed wires, which form a junction where one wire crosses another, and at least one connector species connecting the pair of crossed wires in the junction. The junction has a functional dimension in

nanometers. The at least one connector species and the pair of crossed wires forms an electrochemical cell. The method comprises biasing both wires at least once with a first voltage sufficient to cause an electrochemical reaction in the connector species and switch its state, wherein the at least one connector species comprises an electrically addressable molecular species.

Claims 50-56 and 60 depend, either directly or indirectly, from Claim 14.

The Examiner argues that Nagasubramanian et al show a method of operating a crossed wire device (citing the cover Figure and Col. 2, line 47 et seq.) where the junction of the crossed wires has a connector species with TCNQ between (citing Col. 3, line 18), the thickness of the TCNQ layer is about 1 micron which includes less than 1 micron and is thus in the nanometer range and is, in effect, an electrochemical cell. The Examiner further contends that the method shown involves biasing the crossed wires to cause an electrochemical reaction and switch the state of the material.

The device of Nagasubramanian et al employs a thin film of an organic conducting ***polymer***. There is absolutely not the slightest disclosure or suggestion of a molecule or molecular layer serving as a connector species to provide switching at a nanometer scale.

Further, the organic conducting polymer of Nagasubramanian et al is a charge transfer complex, comprising polypyrrole doped with TCNQ. Such a complex is clearly not an electrically addressable molecular species, as stated in Applicants' specification on page 3, lines 9-11 and as recited in Applicants' Claim 48. A charge transfer complex formed between two electrodes hardly discloses or suggests an electrically addressable molecular species between two electrodes.

In addition, the thickness of the polymer, that is, the functional dimension of the device of Nagasubramanian et al, is about 1 μm (Col. 4, lines 13-15). In contrast, Applicants' Claim 14 recites that their junction has a functional dimension in nanometers, defined on page 6, lines 20-21, as 0.1 to 50 nm. Clearly, a functional dimension of 1 nanometer, being 1,000 times smaller than 1 micrometer, is totally different than a functional dimension of 1 micrometer. There is no disclosure or suggestion in Nagasubramanian et al that their functional dimension (the thickness of their polymer film) could be reduced to nanometer scale dimensions and still provide a working device that would in any way disclose or suggest Applicants' claimed device.

As stated on page 3, lines 22-24, the electronic device of the present invention, in one realization, is a quantum state molecular switch comprising an electrically adjustable tunnel junction between two wires. Applicants' molecules switch because Applicants electrically adjust the tunnel barrier of the molecules via a change in the chemical state of their molecular switches (page 4, lines 1-2). Thus, since Applicants are utilizing tunneling, the spacing between the molecules has to be on the order of one or two nanometers, i.e., a single molecular thickness, because if the space is much larger, then the tunneling will be so small that the resistance of the 'ON' state will be too large to be useful. This is totally different from the Nagasubramanian et al junction, which was about one micrometer thick. Tunneling can play no role in the operation of the Nagasubramanian et al switch, since one micrometer is far too thick for an electron to tunnel through at all.

Finally, the switching behavior of the device of Nagasubramanian et al is based on ***available carrier (electrons or holes)*** switching; see, e.g., Col. 4, lines 16-37, which describes switching between an insulating state and a conducting state. Such switching occurs as a result of the migration of electrons of TCNQ into the polypyrrole and back, in response to external stimulus (voltage applied across the desired row and column conductors). Available carrier switching is clearly different than molecular switching; the former relies on controlling the available number of carriers (electrons or holes), while the latter relies on switching between different chemical states of the molecule.

For the foregoing reasons, Applicants' claims are neither anticipated nor even remotely suggested by Nagasubramanian et al

Reconsideration of the rejection of Claims 48, 50-56, and 60, as amended, under 35 USC 102(b) as being anticipated by Nagasubramanian et al is respectfully requested.

Claim 43 is rejected under 35 USC 103(a) as being unpatentable over Nagasubramanian et al, *supra*.

Applicants' Claim 43, which depends on Claim 57, specifies that the device is irreversibly switchable from a first chemical state to a second chemical state of the bistable molecule.

Since Claim 48 (from which Claim 57 depends) has been argued above to patentable over Nagasubramanian et al, then Claim 43 should also be patentable thereover.

Reconsideration of the rejection of Claim 43 under 35 USC 103(a) as being unpatentable over Nagasubramanian et al is respectfully requested.

Claims 44-47 and 57-59 are rejected under 35 USC 103(a) as being unpatentable over Nagasubramanian et al, *supra*, in view of Potember et al (U.S. Patent 4,371,883).

The Nagasubramanian et al reference is discussed above. Potember et al disclose a current-controlled bistable electrical organic thin film switching device. A current-controlled, bistable threshold or memory switch comprises a polycrystalline metal-organic semiconductor sandwiched between metallic electrodes. Films of either copper or silver complexed with TNAP, DDQ, TCNE, TCNQ, derivative TCNQ molecules, or other such electron acceptors provides switching between high and low impedance states with combined delay and switching times on the order of 1 nanosecond. Switching behavior of a complex of the present invention is related to the reduction potential of the acceptor molecule.

Claims 44-47, which indirectly depend from Claim 48, are directed to irreversible switching, reversible switching, and aspects of the connector species. Claims 57-58, which depend, indirectly or directly, from Claim 48, specify that the at least one connector species comprises a bi-stable molecule (Claim 57) that displays a significant hysteresis in its current-voltage curve, obtained either from solution electrochemistry or from current-voltage characteristics in a solid-state junction (Claim 58). Claim 59 states that the at least one connector species is either oxidized or reduced.

Essentially, the Examiner argues that Potember et al provide those aspects of the claimed invention that are not taught by Nagasubramanian et al.

The arguments regarding Nagasubramanian et al made above obtain here as well.

With regard to Potember et al, again, organic thin films are used, comprising electron acceptors (e.g., TCNQ) combined with a metal (Cu or Ag). The films of Potember et al are 1 to 10 μm thick (Col. 4, line 27); obviously, these are not nanometer scale dimensions, as claimed by Applicants. That is to say, the functional dimension

claimed by Applicants in nanometer scale dimensions (defined on page 6, lines 20-21 as 0.1 nanometers to 50 nanometers) is hardly suggested by a reference disclosing a functional dimension in the range of one thousand to ten thousand nanometers. Further, the films of Potember et al are polycrystalline (Col. 4, line 27); obviously, these are not bi-stable molecules. Additionally, the films of Potember et al are, like Nagasubramanian et al, charge transfer complexes. Again, a charge transfer complex formed between two electrodes hardly discloses or suggests a molecular species between two electrodes, even if both devices employ electrochemical changes.

Clearly, combining Nagasubramanian et al and Potember et al utterly fails to disclose or even remotely suggest the use of bi-stable molecules as the switching medium between two electrodes, as claimed by Applicants.

The amendment to Claim 48, from which Claims 44-47 and 57-59 depend, overcomes the comments by the Examiner regarding these dependent claims, inasmuch as neither reference, alone or in combination, discloses ore even remotely suggests that the connector species comprises an electrically addressable molecular species.

Reconsideration of the rejection of Claims 44-47 and 57-59 under 35 USC 103(a) as being unpatentable over Nagasubramanian et al in view of Potember et al is respectfully requested.

Claim 49 is rejected under 35 USC 103(a) as being unpatentable over Nagasubramanian et al in view of Potember et al and further in view of Aviram et al (U.S. Patent 3,833,894).

Nagasumbramanian et al and Potember et al are discussed above. Aviram et al disclose an organic memory device comprising an organic compound having a molecular structure which includes a mixed valence double well of an organic or organometallic redox couple separated by a sigma (non-conjugated) bridge, the two components of the redox couple being the respective end groups of the structure.

Applicants' Claim 49, which depends from Claim 48, specifies that the at least one connector species forms a quantum state molecular switch comprising an electrically adjustable tunnel junction between the two wires.

The Examiner argues that Aviram et al show that a tunnel junction device can be formed (citing the Abstract) in an x-y matrix using TNCQ (citing Col. 8, line 68) and

further show that the device can be controlled with optical and thermal means as well as electrical means. The Examiner contends that it would be obvious to use the Aviram et al structure in the Nagasubramanian et al and Potember et al device to provide the extra degrees of control and thus expand the utility of the device.

Applicants' arguments regarding Claim 48 made above obtain here as well. Since Claim 49 depends from Claim 48, this claim is also considered to be patentable over the combination of references.

Reconsideration of the rejection of Claim 49 under 35 USC 103(a) as being unpatentable over Nagasubramanian et al in view of Potember et al and further in view of Aviram et al is respectfully requested.

The foregoing amendments and arguments are submitted to place the application in condition for allowance. The Examiner is respectfully requested to take such action. If the Examiner has any questions, he is invited to contact the undersigned at the below-listed telephone number. HOWEVER, ALL WRITTEN COMMUNICATIONS SHOULD CONTINUE TO BE DIRECTED TO: IP ADMINISTRATION, LEGAL DEPARTMENT, M/S 35, HEWLETT-PACKARD COMPANY, P.O. BOX 272400, FORT COLLINS, CO 80527-2400.

Respectfully submitted,

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